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SOME MEASUREMENTS OF ATMOSPHERIC RADIO-ACTIVITY IN BERKELEY.

Submitted in Partial Satisfaction of the

Requirements for the Degree of

Master of Science

in the

University of California

by

Frederic Addison Harvey.

1906

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SOME MEASUREMENTS OF ATMOSPHERIC RADIO-ACTIVITY IN BERKELEY.

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The fact that a charged body inside a closed vessel loses its charge more rapidly than may be explained by leakage across the supports has been established by C.T.R.Wilson (1) and by Geitel (2). Experiments conducted in the open air by Elster and Geitel (3), give the same results, and the loss by a negatively charged body is usually more rapid than by one positively charged. In the light of the then recent work on radio-activity Elster and Geitel considered that this might be due to some radio-active substance in the atmosphere, so they exposed a negatively charged wire netting (4) to see whether excited activity might not be collected on it, as in the case of a body exposed to the emanation from Radium or Thorium. To test this they used the electrical method, which depends on the property of radio-active material by which it ionizes the gas near it which in turn increases the rate of discharge of any charged body with which it comes in contact. Elster and Geitel used an electroscope. The results at first obtained were slight but by increasing the negative potential from 400 to several thousand volts, and using a long wire, the rate of discharge of the electroscope was increased six-

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(1) Geitel, Phys. Zeit. 2. p.116. 1900.
(2) Wilson, Proc. Cam. Phil. Soc. 11 p. 32. '00 & 63 p.151 '01

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fold. A positively charged wire produced no acceleration of the rate of discharge. They found that the material of the charged body did not have any effect on the amount of activity collected; obtaining the same results with wires of iron, copper, aluminium, lead, with leaves of plants, etc. The activity was not permanent but decayed on a few hours in a manner resembling Thorium X. The rate of decay was not hastened by heating. The activity might be rubbed from the wire by using a piece of leather dipped in ammonia or hydrochloric acid, and on heating to drive off the liquid, remained on the leather. When so concentrated there was enough radio-activity to make a barium-platino-cyanide screen glow quite perceptably to the rested eye, or to give a shadow picture on a photographic plate thru aluminium 0.1mm in thickness. The amount of activity which may be collected in caves and holes, where the air has been long stagnant, is much greater than in the open air. The activity can only be collected in large spaces, i.e. several cubic meters, and disappears altogether in smaller ones. Thus a wire exposed in a bell jar under the same conditions shows no activity. Showing that the activity cannot be due to the action of a strong magnetic field on the surface of the wire.

Elster and Geitel (1), and later Bumstead and Wheeler (2)

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(1) Elster and Geitel, Phys. Zeit 3 p574. 1902.

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have tested the air drawn from underneath the soil to see whether an emanation comes up thru the surface of the earth or whether the effect is due to an effect of the stagnant air itself. Air shut up in a large boiler by itself for several weeks showed no observable increase in activity. On the other hand, air sucked from a few feet below the surface of the earth, by means of a pipe and water pump, and introduced into a large bell-jar containing an electroscope, surrounded by an earthed wire net, caused a very decided increase in the rate of discharge of the electroscope, which reached a maximum after several hours, as great in one case as thirty times the original rate of leak. The same is true of air taken from the surface water near New Haven.

These experiments prove unquestionably that the activity collected on a negatively charged wire is due to an emanation from the soil, which diffuses thru the air above it. This emanation gradually breaks up giving rise to positive radio-active carriers, which normally collect on the surface of the earth, buildings, and all projections, such as mountain peaks, (this explains the higher degree of ionization there observable)because of the slight negative charge of the earth. The higher negative potential of the wire merely increases the number of radio-active carriers collected.

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giving rise to the radiations observed.

The Emanation may be extracted from the air by condensation in liquid air as in the case of the radium and thorium emanations. Active air is liquified and allowed to partially volatilize; concentration being obtained because the emanation volatilizes at a lower temperature than the air.

C.T.R.Wilson has shown that freshly fallen rain carries down some of the radio-active carriers. On being evaporated to dryness in a platinum dish there is a radio-active residue, Enough activity remained after evaporating about 50cc. of rain water to increase the rate of discharge of an electroscope four or five times after passing thru a thin layer of aluminium. The activity decayed, falling to half value in about 30 minutes. Rain water a few hours old showed no activity. Wilson found also that the air bubbled thru Cambridge tap-water shows increased conductivity.(1) Allan (2) also tryed the conductivity of air bubbled thru tap-water, in Canada, and while he found an increased saturation current it was due to the water vapor carried up by the air. He concluded that this was also the explanation of the results obtained by Wilson, but later experiments have shown that the Cambridge tap-water does contain a radio-active emanation. An examination of the water from deep wells in

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(1) C.T.R.Wilson, Proc. Cam. Phil. Soc. 11 p428, 1902

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various parts of England, shows that some of it contains a large amount of the emanation. Also an examination of various mineral springs has shown that many of them contain radio-active emanation.(1) The mud and silt around such springs sometimes contains radium, sometimes thorium, or both in varying proportions. This will be referred to later. The activity may be precipitated from rain water by adding a little barium chloride and precipitating with sulphuric acid, or by adding alum and precipitating with ammonia. Freshly fallen snow also shows a slight amount of radio-activity on evaporating to dryness.

Meteorological conditions have a very great effect on the amount of radio-activity in the air. Elster and Geitel (2) have made a very extended series of observations on this point. They found that the amount collected during a high wind was very much greater than that collected on a still day, which is to be expected since the electric field only draws the active material from the air for a radius of about one meter, as shown by Eve, for a potential of about -10,000 volts. The wind consequently brings a much larger volume of air within the influence of the field. The direction of the wind seems also to have an effect, depending on

(1) H.S.Allen and Blythswood, Nature 68 p343 1903. 69 p247 .04 Strutt. Proc. Roy. Soc. 73 p191 1904. Himstedt. Ann.d. Phy. 13 p191 1904. Elster and Geitel, Phy. Zeit. 5 No. 12 p 321 1904. and others.

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the locality in which the observations were carried out, that is the nature of the surface over which it comes. Temperature has a very marked effect, the activity being greater at lower temperatures. Lower barometric pressure increases the amount of activity, but whehter this is due to the air being drawn up thru the capillaries of the earth at the lower pressures or to the altering of the level of underground water is as yet undecided. More activity is usually observable on a bright, clear day than when it is cloudy, but the presence of condensed water vapor, increases the amount, Elster and Geitel finding the greatest amount of activity during a fog of any time during their observations. This is probably due to the fact that the drops become themselves centers for the positive carriers which are thus held from being removed by the earth's field, but are drawn out by the strong field about the wire and manifest themselves at its surface.

The question of the nature of the emanation which produces these phenomena of atmospheric radio-activity has been made the subject of investigation by many observers, and has yielded apparently diverse results. The usual method of attack is to observe the rate of decay of the activity produced on a wire and compare it with the known rates of decay of radium and thorium. Allan (1) working at Montreal,

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Canada, came first to the conclusion that it was entirely due to radium emanation, since the induced activity fell to half value in about 45 minutes, which is the case with radium induced activity,but it is to be noticed that he reconed from a time ten minutes after the discharge of the wire. Later he found that the activity transferd to a piece of leather moistened with ammonia fell to half value in about 28 minutes while for a piece of felt treated in the same way half value was reached only after 60 minutes, the time for the wire itself being 45 minutes, as given above. From this he reached the conclusion that there are several kinds of activity in the atmosphere and that the differance in the rate of decay is due to different proportions of the several substances being transferd to the felt and leather. Rutherford thinks this due to the fact that a greater proportion of Radium B than Radium C is transferd in the second case (see Rutherford's Radio-activity, second edition, page 523) which would make the rate of decay slower. Bumstead (1) has obtained undoubted evidence that thorium exists in the emanation at New Haven. He observed the rapid initial drop due to radium, missed by Allan because he did not begin his observations until ten minutes after the wire had been discharged and the first drop reaches half value in about three minutes, and then a slower fall extending over a period of several days,

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in case of a long exposure. He states his conclusions as follows:- 1. The radio-activity acquired by a negatively charged wire exposed in the open air (at least as observed at New Haven) is mainly if not wholly due to the excited activities of radium and thorium. With a three hour exposure 3 to 5 per cent of the total initial effect is due to thorium activity, the proportion depending apparently upon the greater or less ease with which the emanations escape from the soil. With a twelve hour exposure the thorium activity is sometimes 15 per cent of the whole, and with a long wire its decay may be followed for several days. There is some evidence that a small quantity of a more rapidly decaying activity is present in addition, but these experiments do not definitely establish this. 2. The radio-activity of rain and snow is probably due to radium-excited activity, the absence of the thorium effect being accounted for by the fact that the rapid decay of the thorium emanation prevents its reaching, in appreciable quantities, the height at which the rain-drops are formed.

As stated on page 5, it has been found that sediments from mineral springs and the like differ as to the radio-active constituents; the conclusion is natural and obvious that the radio-active elements are not evenly distributed over the earth's surface, hence there is no need to attempt to reconcile diverse results obtainedin different localities.

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It might even be expected that different winds in the same place would give different results. Radium, thorium, and actinium may be present in varying quantities and Ewers and Ebert as well as Bumstead have obtained incomplete evidence that still another radio-active substance, as yet unknown exists.

The Electroscope used in the present series of measurments was of the following construction:- The system supporting the aluminium leaf consisted of an ebonite rod, "b", Fig. 1., 1 cm. in diameter and 12 cm. long, closely fitted into a hole at "a". Into this rod a 6 cm. length of 0.2 cm. brass rod was screwed, towhich was fastened an aluminium plate, "c", about 5x5 cm. By bringing up two similar, earthed plates, one on either side, the capacity of this conductor was increased and the rate of leak decreased. "d" is a sulphur rod about 5cm. long which supports and insulates the aluminium leaf, "e". The system

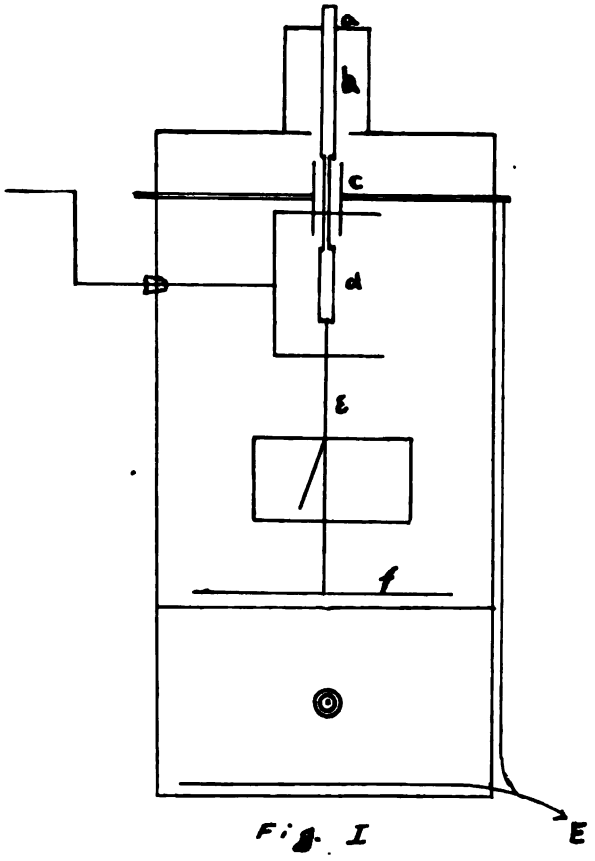

Fig. I

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terminates in a circular plate "f", which may be removed altogether or one of smaller diameter substituted, to vary the sensitiveness of the instrument.

The box surrounding this system is of wood, lined with tin foil as far down as the plate "f", made as nearly air-tight as possible. It is provided with a drawer below the plate "f" in which the wire may be placed after being wound in the form of a helix. A metal diaphram may be slipped in just above the drawer to prevent any air currents in the upper part of the box when introducing the wire, A wire passing thru a rubber stopper in the side of the box serves to charge the two conducting systems to the same initial potential and since the rate of leak of the lower system due to the radio-activity is much greater than that of the upper system, any leak across the sulphur rod will tend to make the results obtained smaller. With this arrangement the rate of leak was made about 1 degree an hour, which is negligible in comparison with the rate of leak due to the induced radio-activity in all cases.

In order to observe the fall of the leaf the following arrangement was finally adopted. The image of a circular scale graduated in degrees, of radius equal to the length of the leaf, was superposed on the leaf by means of a half-silvered mirror placed in front of the observing telescope at an

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possibleby the parallax test so that the telescope might be moved to follow the leaf around the scale without appreciable error.

The wire used was of copper, No. 18 B&S gauge, about 14 meters in length, and supported by means of ebonite rods 40cm. long. The distance of the wire above the ground was about 4 meters. All the exposures were made on the east side of South Hall.

The potential was maintained by means of a water-dropper with which, after a small reservor with over-flow pipe, had been adopted to give constant pressure, the potential could be held practically constant for any length of time on dry days. During one 14 hour exposure the potential did not change by more than 100 volts in about 5000 during the entire exposure. On damp days the potential usually fell off a little after about three hours. The potential was measured by means of a Braun Electroscope reading directly in volts.

The method adopted to determine the rate of discharge of the electroscope was to take readings of the position of the leaf at regular intervals, plot the curve of position with the time, and then determine the tangent of the curve. This could be done with much greater accuracy than to read the fall of the leaf during an interval of time, say two

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minutes at the beginning of the curve, and divide by the time to get the rate of fall at the middle point. The greatest rate of fall of the leaf during two minutes was not more t than 5 degrees, which,since tenths must be estimated, gives a possible error of 20%, while with the method adopted the errors correct themselves in the first curve and the tangents can be determined within one per cent or even c closer. The potential of the aluminium leaf was compared with the Braun electrometer, with the following results for various deflections:-

Deflections, in degrees,	Volts,
49	1280
43	1000
30.5	700
27.4	600.

This is much more than sufficient to give the saturation current, but as a further test the rate of fall when a sample of uranium oxide was introduced was observed over the entire scale and by recharging and it was found that the rate of fall was not different from 60 to 55 degrees from that from 20 to 15 degrees. It may also be said here that the recharging of the electroscope during a set of observations cannot be the cause of the inflexions in the curves as this point has been thoroughly tested. The sensitiveness of the electroscope did not vary sensibly from day to day.

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convenience the original numbering is retained.

Curve No. 4.

Wire exposed 10:20A.M. to 1:20 P.M. 3 hours.

Potential = -3600 volts. Temp. 64F. Barometer = 29.82in.

Rather high north by east wind. Very dry and clear. 14 m.

No. 18 B&S copper wire, 4m. above the ground.

Time	Reading	Total time	I	log. I
11:54	36.2°	0		
1:02	35.2	1hr. 8min.	.0147	
		Introduced wire		
1:27:40	38.8	40sec.		
1:28:40	37.2	1min 40sec.		
1:29:40	35.9	2 40		
1:30:40	34.4	3 40		
1:32	32.4	5	1.434	.153
133	31.0	6		
1:34	29.7	7		
1:35	28.	8		
1:36	26.9	9		
1:37	25.3	10	1.202	.080
1:38	24.	11		
1:39	22.9	12		
1:40	21.6	13		
1:41	20.4	14		
1:42	19.4	15	1.041	.017
1:44	17.8	17		
1:46	15.2	19		
1.47		20	.850	.929
1:48	13.6=35.2	21		
1:50	33.7	23		
1:52	31.3	25	1.202	. 080
1:54	29.4	27		
1:56	27.2	29		
		30	1.061	.026
1:58	25.1	31		
2:00	23.1	33		
2:02	21.2	35	.899	.954
2:04	19.7	37		
2:06	17.4	39		

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Time	Reading	Total time	I	log.I
2:08	16.2	41		
1:10	14.8=38.8	43		
1:12	37.2	45	.708	.850
2:17	33.4	50	.584	.766
2.22	29.8	55	.542	.734
2:27	27.3	60	.626	.797
2:32		65	.678	.831
2:37	20.3	70	.552	.742
2:47	16.4	80	.360	.556
2:57	13.2=37.7	90	.324	.510
3:07	34.7	100	.2845	.454
3:17	31.9	110	.244	.387
3:27	29.6	120	.2295	.361

see curves.

Curve No.5 .

Wire exposed 1:37 to 3:40 P.M. Potential= 4,000 to 5,000 volts. Conditions as in curve 4. April 3d '06

Time	Reading	Arbitrary scale	Total time	I	log I
3:40:40	37.9	100	40sec		
3.41:40	36.7	98.8	1 min 40sec		
3.43	34.6	96.7	3		
3:44	33.3	95.4	4		
3:45	32.2	94.3	5	1.292	.111
3:47	29.8	91.9	7		
3:50	25.9	88.0	10	1.155	.063
3.54	21.4	83.5	14		
			15	1.067	.028
3:56	19.1	81.2	16		
4:00	15=39.0	77.1	20	.991	.996
4:02	37.5	75.6	22		
4:04	35.0	73.1	24		
			25	.968	.986
4:06	33.3	71.4	26		
4:08	31.2	69.3	28		
4.10	29.3	67.4	30	1.005	.002
4:12	27.2	65.3	32		
4:14	25.5	63.6	34		
			35	.889	.954
4:19	21.0	59.1	39		
			40	.792	.899
4.24	17.4	55.5	44		

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Time	Reading	Arbitrary scale	Total time	I	log I
4:29	14.8=44.6	52.9	49		
			50	.428[illegible]	.630
[illegible]:34	42.0	50.3	54		
			55	.664	.822
4:39	37.9	46.2	59		
			60	.825	.916
			65	.674	.829
4:50	30.3	38.6	70	.594	.774
5:00	25.8	34.1	80	.399	.601
5:10	22.2	30.5	90	.2905	.463
5:20	19.2	27.5	100	.241	.382
5:30	16.7=41.8	25.0	110	.194	.288
5:40	40.5	23.7	120	.174	.240
5:55	38.0	21.2	135		
			140	.096	.982
[illegible]			180	.066	.819
6:56	31.2	14.4	236	.066	.819
7.10	30.0	13.2	250		
7.25	29.1	12.3	305		
		++++++++++			
		Curve No.6.			

Started wire at 7:15P.M. dry, clear, high north wind all night. Bar.=29.8 Temp. about 40F.Time of exposure 12hr.45min.

8:02:30	35.2	200	2.5min		
8:03	34.2	199	3		
8:04	31.4	196.2	4		
8:05	28.4	193.2	5	2.571	.4101
8:06	26.6	191.4	6		
8:07	22.8	187.6	7		
8:08	20.6	185.4	8		
8:09	18.0	184.8	9		
8:10	15.8	182.6	10	1.475	.1687
8:12	12.4=51.5	179.2	12		
8:14	49.3	177.0	14		
8:15	44.4	172.1	15	1.82	.2600
8:16	39.2	166.9	16		
8:18	34.5	162.2	18		
8:20	29.8	157.5	20	2.142	.3312
8:22		[illegible]	22		
8:24	25.4	153.1	24		
			25	2.000	.3010
8:26	20.9	148.6	26		
8:28:30	16.6	144.3	28.5		
8:30	14.5=47.8	142.2	30	1.970	.2945
8:32	45.0	137.9	32		
8:34	41.0	133.9	34		

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Time	Reading	Arbitrary scale	Total Time	I	log I.	16.
8:36	37.0	129.9	36			
8:38	33.2	126.7	38			
8:40	29.4	122.3	40	1.700	.2305	
8:42	25.5	118.4	42			
8:44	22.3	115.2	44			
	19.2		45	1.602	.2047	
8:46	19.2	112.1	46			
8:48	16.7=42.8	109.6	48			
8:50	40.4	106.7	50	1.570	.1959	
8:52	37.0	103.3	52			
8:54	33.8	100.1	54			
			55	1.452	.1620	
8:56			56			
8:58	27.6	93.9	58			
9:00	24.4	90.7	60	1.216	.0849	
9:05	19.5=47.5	85.8	65	1.033	.0141	
9:10	43.0	80.3	70	.952	.9786	
9:15	38.1	75.4	75	1.208	.0821	
9:20	32.0?	69.3	80	1.095	.0394	
9:25	28.2	65.5	85			
9:30	23.7	61.0	90	.771	.8870	
9:40	17.0=44.2	54.3	100	.692	.3801	
9:50	38.2	48.3	110	.616	.7896	
10:00	31.8	41.9	120=2hr.	.533	.7267	
10:16	23.6=52.2	33.7	2.25hr.			
10:30	46.6	28.1	2.5	.380		
10:45	40.8	22.3	2.75			
11:00	34.8	16.3	3.00	.367		
11:15	28.8	11.3	3.25			
11:25	26.7					
11:30	25.2	6.7	3.5hr.	.295		
11:35	23.6=55.4					
11:55	48.1	-1.8				
12:00			4.0			
12:05	45.7			.240		
1:00	30.9	-19.0	5.0			
1:05				.130		
1:10	20.6					
	20.0=41.4					
1:50	41.1					
2:00	30.1	-32.2	6.0	.200		
2:10	37.1					
2:49	20.1	-48.1				
3:00			7.0	.2105		
3:17	23.2					
	23.0=49.8					
3:51	43.8	-60.2				
4:00			8.0	.1784		
4:19	37.8					

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Time	Reading	Arbitrary	Total Time	I	log I
7:31	22.8				
7:41	20.1				
7:46	19.4	-105.3	11.75	.2	
	19.0=44.9				
and	20.0=55.7				
10:23	55.7				
10:30	54.8	-131.5	14.5	.123	
10:40	53.6				
11:00	51.6				
11.30	47.9			.123	
	natural fall of electroscope				
11.32	50.2				
11.42	49.9			.025	
11:52	49.7				
	wire returned				
11:55P.M.	45.4=66.2				
7:58A.M.	59.3	-190.9	24hr.	.0606	
9:04	35.3				
	wire out, i.e. natural fall				
9:08:30	37.1				
10:02	35.2			.034	
	++++++++++				
	Curve 12.				

Wire out 9:25 A.M. to 1.30P.M. 4 hr. Potential about 3250 v. Bright, clear day, very light south-west wind. Bar. 29.9 Temp. 34C

	Natural fall.				
9:33:30	54.8				
10.35	54.8				
11.25	53.6				
1:00	51.3			.0265	
	Wire introduced.				
1:32:30	49.5		2.5min.		
1:35	48.8		5,0	.2242	.3508
1:38	48.1		8		
			10	.1975	.2954
1:41	47.7		11		
1:44	47.05		14		
			15	.1744	.2414
1:47	46.3		17		
1:50	45.8		20	.1744	.2414
1:53	45.2		23		
			25	.1643	.2153
1:56:20	44.6		26.3		
1:59	44.0		29		

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Time	Reading	Arbitrary scale	Total time	I	log I
2:02	43.4		32		
2:05	42.9		35	.1813	.2581
2:08	42.5		38		
			40	.1632	.2127
2:11	41.5		41		
2:14	41.5		44		
			45	.1528	.1838
2:20			50	.1399	.1455
			55	.1249	.0963
2:26	39.6		56		
2:29	39.3		59		
			60	.1168	.0671
2:32	38.9		62		
2:35	38.4		65	.1398	.1450
			70	.1250	.0966
2:41:30	37.6		71.5		
2:47	37.0		77		
2:50	36.65		80	.1120	.0490
			90	.0968	.9860
3:05	35.8		95		
			100	.0812	.9100
3:20	34.0		110	.0734	.8660
3:30	33.3		120	.0656	.8170

++++++++++

See Curves.

It may be said in general that the amount of activity obtained under varying meteorological conditions was what would be expected from the results of Elster and Geitel. The greatest amount was that of curve 6, taken on the third day of a high north by east wind, which is the dry wind in Berkeley, coming over the Sacramento valley. Six curves were obtained during this period, and it as been impossible to repeat them since, owing to lack of a north wind. During the series of measurements there has been no strong south-east wind so that the distinction can only be broadly drawn between

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land and sea winds. These six curves all show <u>two</u> decided inflexions, one occurs variously from 15 to 40 minutes, after the wire is discharged, dependent apparently upon the length of exposure as the following figures show:-

Time of exposure	Time first inflexion
2 hr. 30 min	35 to 40 min.
3 hr.	20 to 25min.
3 hr. 5min.	25 to 30 min.
3 hr. 55 min.	15 min.
12 hr. 45 min.	10 to 15 min.
14 hr. 30 min.	10 to 15 min.

This counts time from the time of discharge of the wire, <u>not</u> from the first observation. The inflexion obtained by Bumstead at New Haven occured always at twenty-five minutes, but he states that the time of exposure was usually three hours and does not give the time for the individual curves, It is to be noted that the inflexion comes at twenty-five minutes for the three hour exposure.

The movement of this inflexion may be accounted for in the following manner. It has been shown that the rate of decay of thorium-excited activity varies with the time of exposure. For a short exposure the rate of decay increases up to about thirty or fourty minutes and then falls off logarithmically. But for a long exposure the rate of decay is at once logarithmic. If now the first inflexion is due to radium its undisturbed position would be about fifteen minutes, but a second inflexion due to thorium supperposed on

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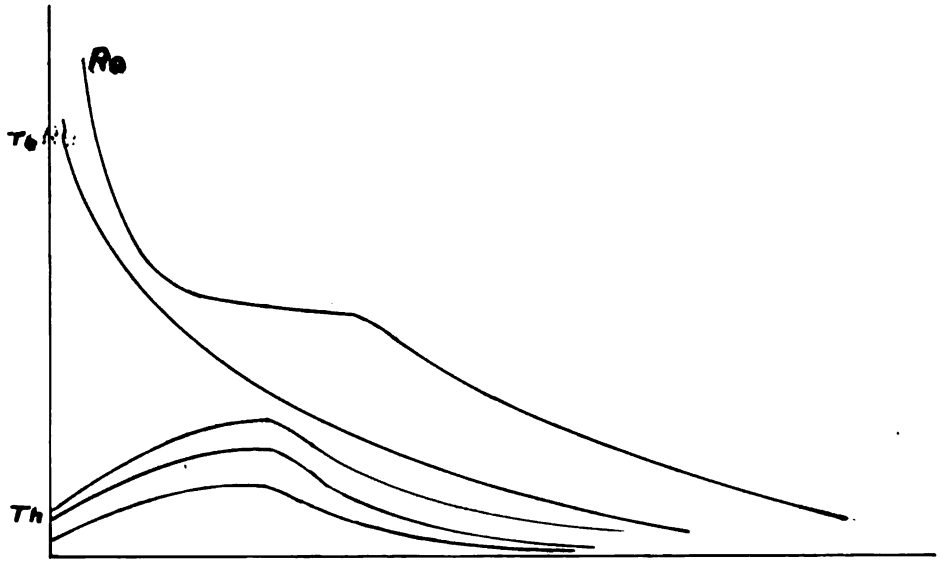
In the case where there is no inflexion due to thorium it actually does come at about fifteen minutes and longer exposure does not seem to produce much further movement in it. It may be represented by the following diagram.



The second inflexion is just as pronounced as the first and occurs apparently always at about 60 minutes, What variation shows itself is not regular with any known condition. I have not been able to trace this inflexion to any of the known radio-active substances and naturally the idea of a new radio-active substance presents itself. Whether this is the sameas that suspected by Bumstead and others in larger proportion cannot be stated at the present time, as they give no indication of a fog in the curve at 60 minutes.

These inflexions seem for the most part to be confined to the six curves obtained during the north wind, but owing to the fact that they reappear in curve 12. taken on a still

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day, I think that merely greater sensitiveness is needed to detect them when an ordinary amount of activity is collected.

The curves are not regularly logarithmic, as the plots of log.I with the time show. In general it might be said that there is a straight line (i.e. the rate of decay is logarithmic with the time) between twenty-five and sixty minutes, but all other cases of logarithmic fall are sporadic. The general statement may also be made that the curves fall to half value in 45 minutes, but the two curves 6 and 7, 12 and 14 hours exposure, show an exception to this. half value being reached only after 60 minutes. This might be expected from the larger per centage of thorium-excited activity present.

I have not been able to combine the known radium and thorium curves to give the curves obtained. The rate of decay during the early part of the curves is much greater than may be explained by any combination of the two. This falls in line with what Bumstead found. see page 8. It also adds to the idea of a new radio-active substance.

As test experiments the rate of discharge of the electroscope was observed when the wire had been exposed without charge and when charged positively to a potential of 1700 volts. In both cases the rate of discharge was decreased. (This is owing to the increased capacity of the system when

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the wire is introduced below the plate of the electroscope. This confirms beyond doubt, if confirmation were needed, the validity of the results.

In conclusion I wish to thank Prof. Lewis for his help and interest in the work.

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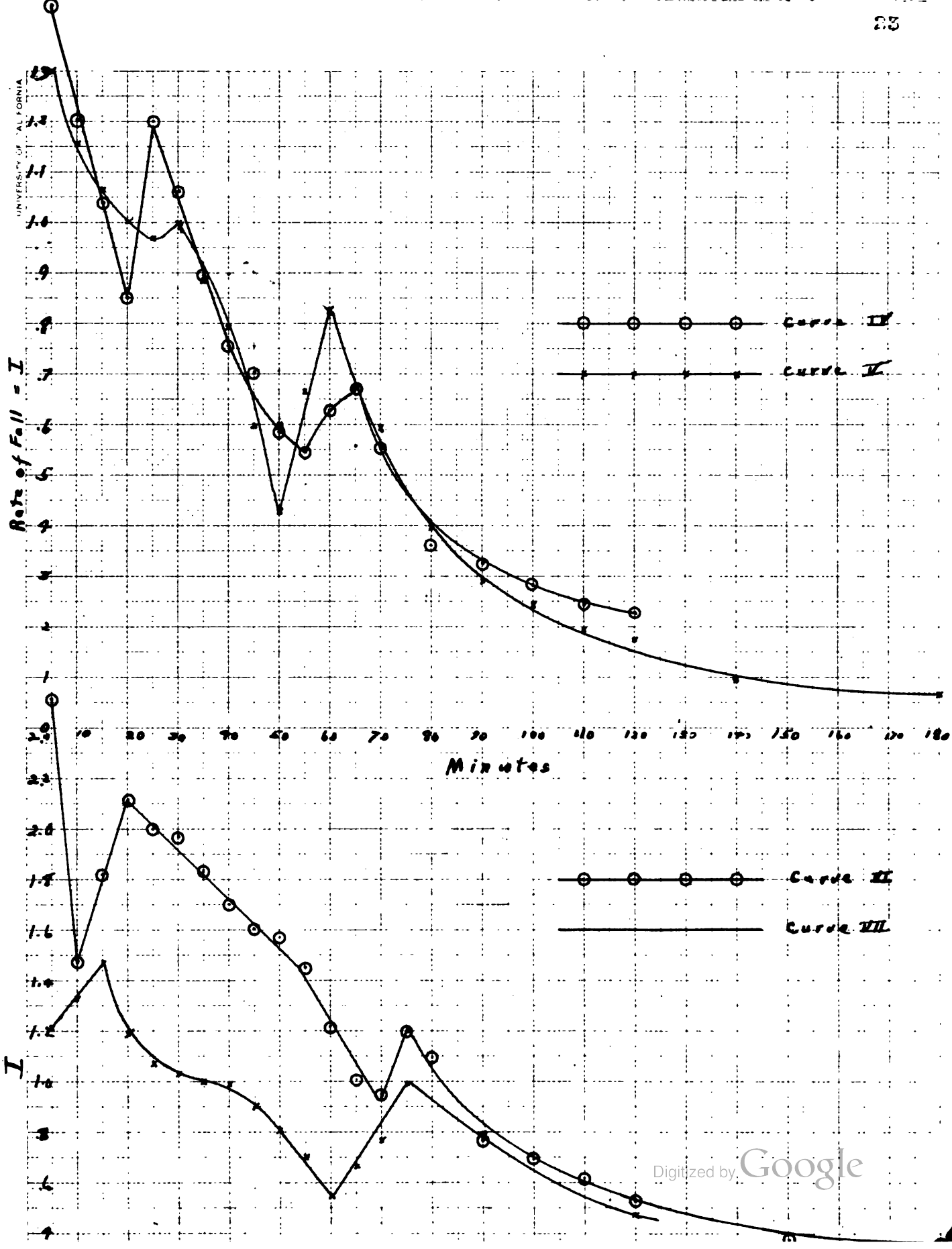

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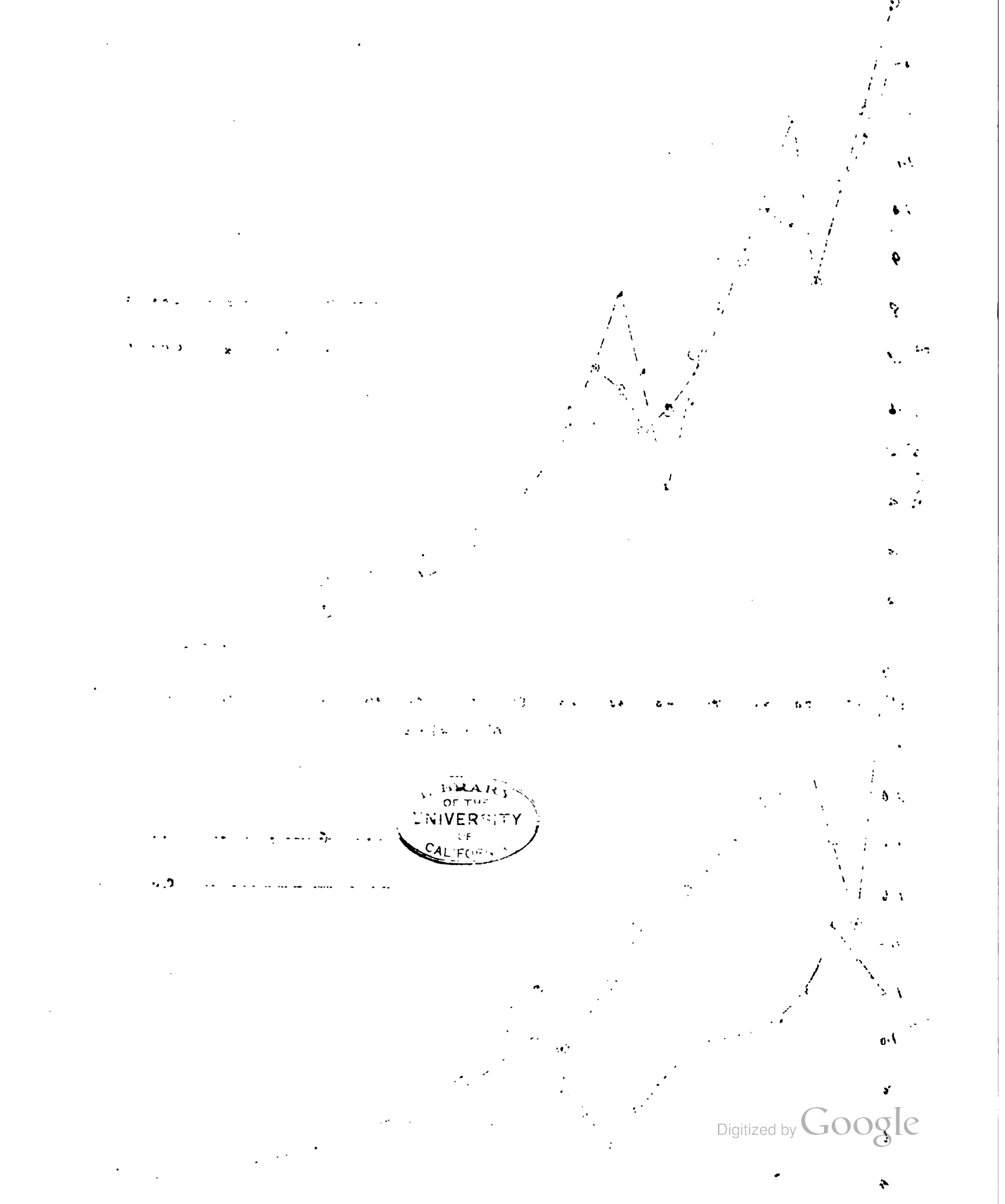
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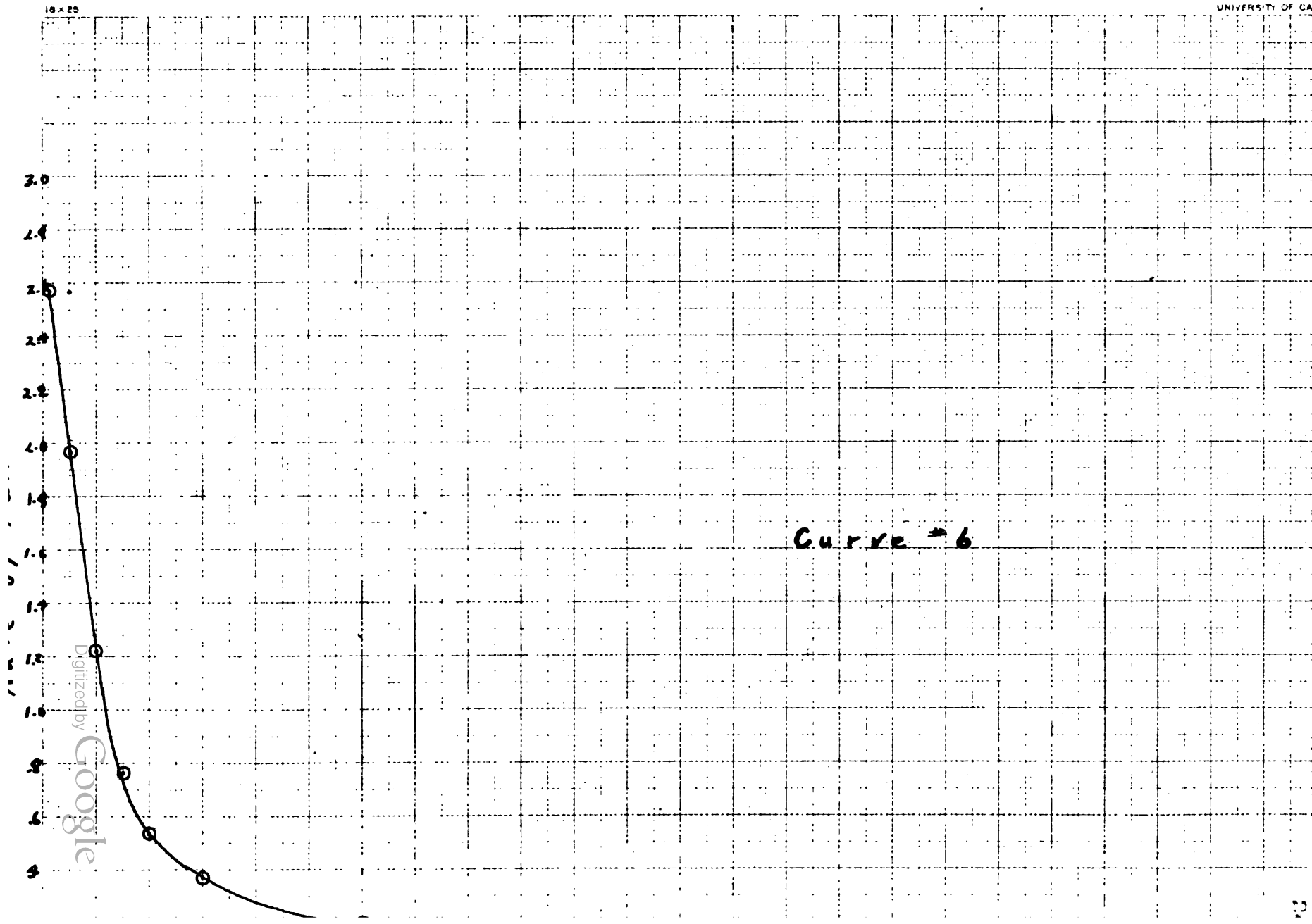

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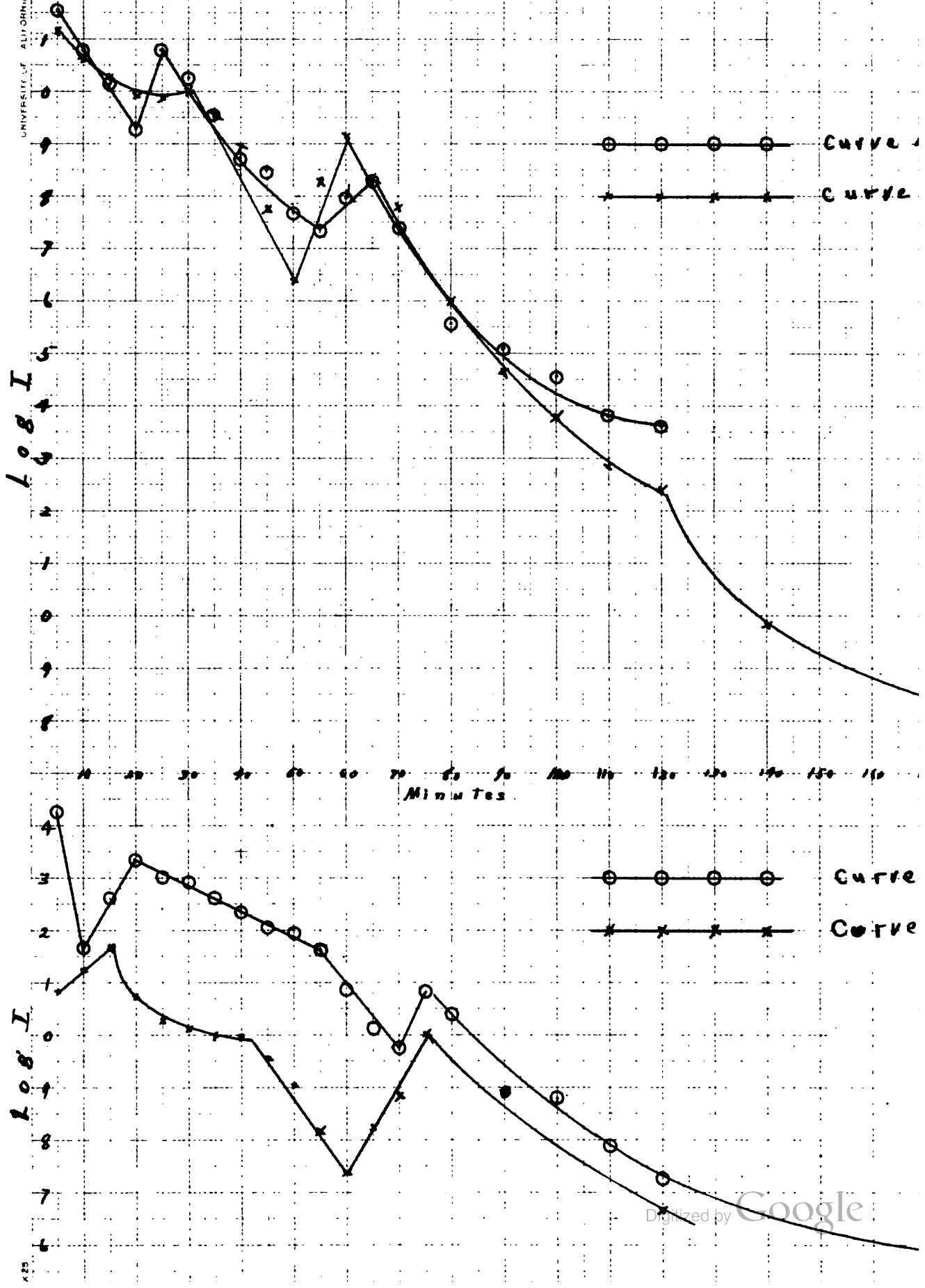

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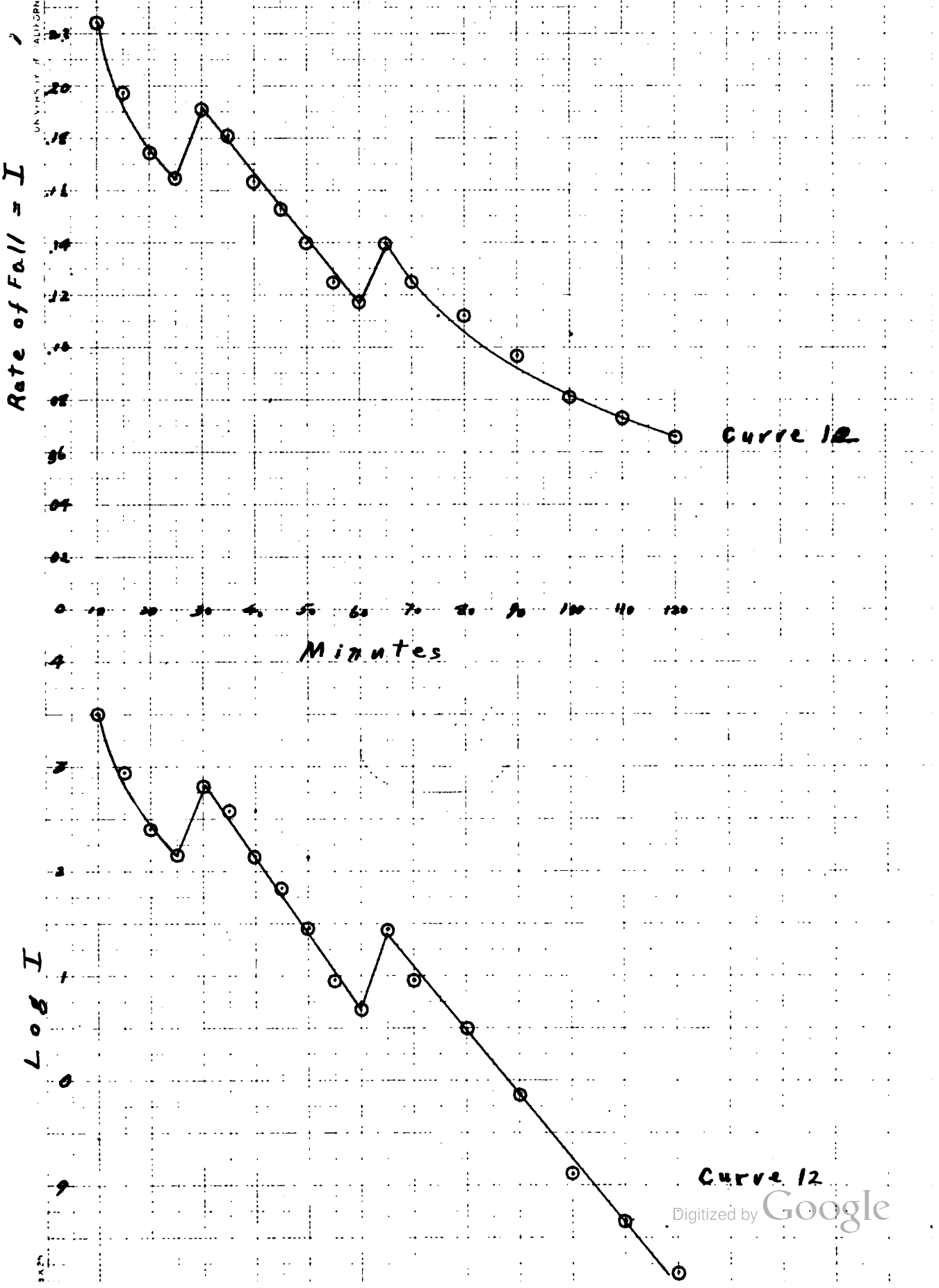

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